Catalogue of American Amphibians and Reptiles.

Grismer, L.L., K.R. Beaman, and H.E. Lawler. 1995. *Sauromalus hispidus*.

Sauromalus hispidus Stejneger
Spiny Chuckwalla

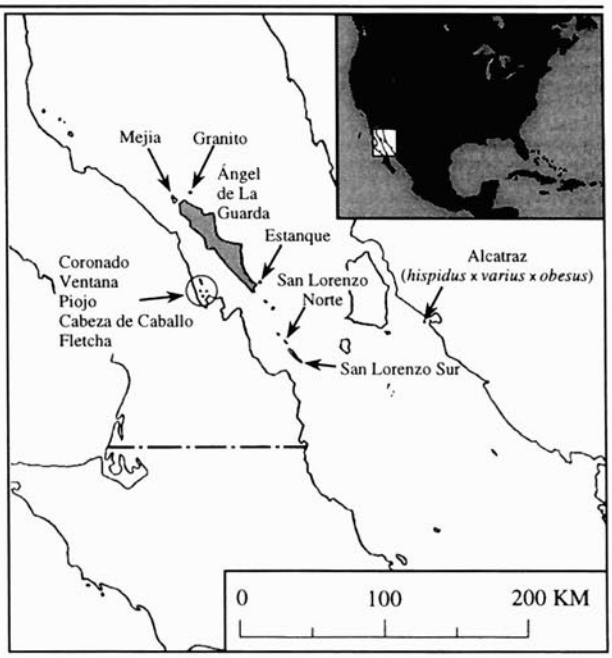
Sauromalus ater: Streets, 1877:36 (part).

Sauromalus hispidus Stejneger, 1891 (1892):409. Type-locality, "Angel de la Guardia [Guarda] Island, Gulf of California [Baja California, México]." Holotype, National Museum of Natural History (USNM) 8563, adult male, collected by Thomas H. Streets, date of collection unknown (catalogued at USNM on 22 August 1876; R.P. Reynolds, in litt., 10.VIII.95) (not examined by authors).

• **Content.** This species is monotypic.

• **Definition.** *Sauromalus hispidus* is a large, stout-bodied, sexually dimorphic species, with maximum head and body size of adult males and females 298 mm and 304 mm SVL, respectively (Case, 1982). This species is the second largest member of the genus.

The head and body are much depressed. The top of the head is covered with rough, irregular scales, which are largest in the frontal and temporal regions and become tubercular and spinose in the latter region. The superciliaries and the supraoculars are small and juxtaposed, the latter tubercular and occasionally weakly spinose. A series of short, carinate suboculars, following the contour of the orbit, pass upward and posteriorly to the anterior border of the ear opening. The labials are small and juxtaposed. The rostral is divided into four nearly equal hexagonal scales. The symphyseal is short, narrow, and subtriangular. A series of enlarged sublabials merge with relatively coarse, spinose, granular gular scales. The prominent gular fold is covered with indistinct spinose scales. The ear



Map. Distribution of *Sauromalus hispidus* (see text).

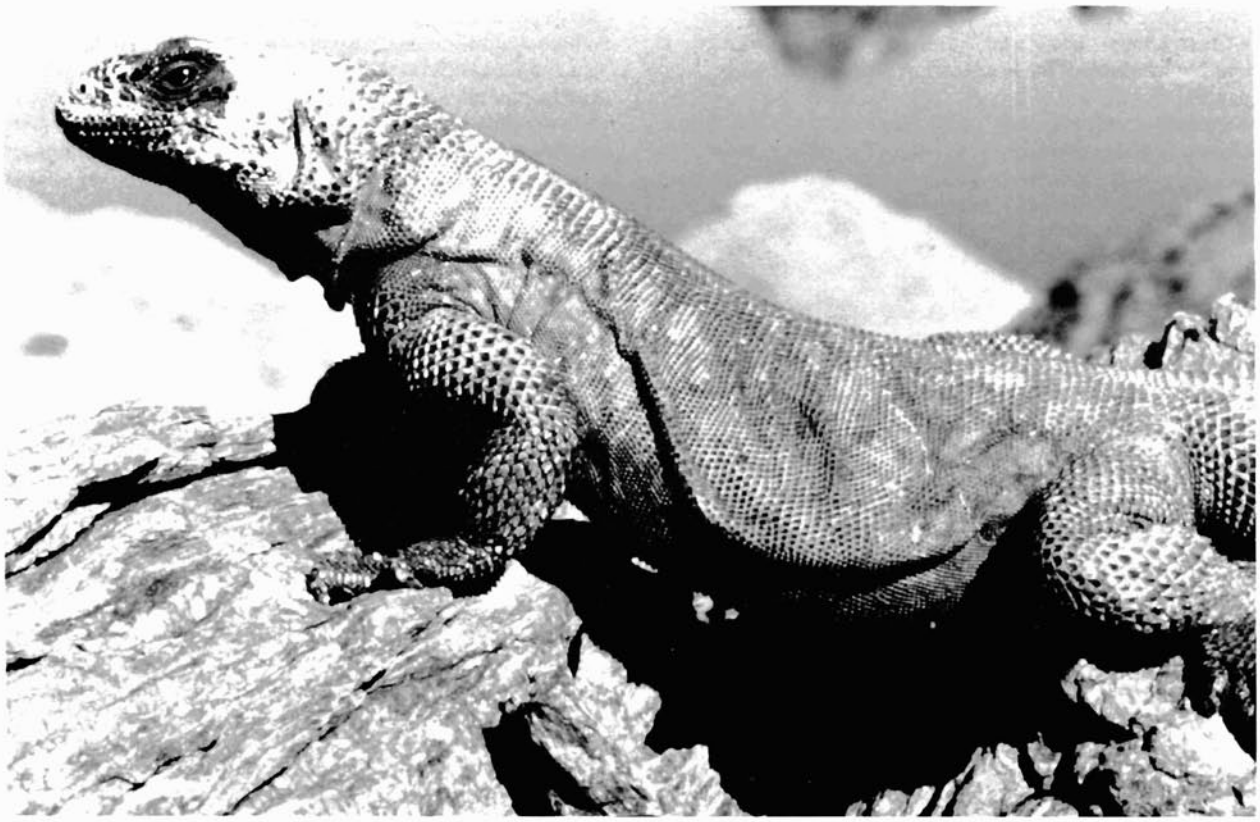


Figure 1. Adult *Sauromalus hispidus* from Ángel de La Guarda, Gulf of California, Baja California, México.

opening is nearly vertical, with an anterior denticulation of 2-4 enlarged spinose scales. A prominent neck fold is covered with enlarged, subconical, strongly spinose scales. The nuchal scales are large, strongly spinose, and grade gradually into a broad median band of spinose dorsal scales extending to the rump. Scales along the lateral fold are enlarged, each containing a stout spine. The ventral scales are smaller than the median dorsal scales and weakly spinose. Scales between the gular fold and the vent are in 108-129 ($\bar{x}$ = 121.4, N = 11) rows (Shaw, 1945). Limb and tail scalation is extremely spinose and moderately to strongly carinate. Femoral pores number 13-17 ($\bar{x}$ = 14.9, N = 11; Shaw, 1945). The unregenerated tail length is 49-53% of the total body length. Scales on the tail are arranged in spirals, and those ventrally are smooth and usually non-spinose whereas those dorsally and laterally are strongly spinose. Caudal scales number 23-28 ($\bar{x}$ = 25.5, N = 11; Shaw, 1945).

Adults are nearly uniform dark-brown or black above, whereas juveniles are transversely banded with dark-brown or black double bands. The ground color between the bands is light with an irregular spotting or streaking of darker color (Shaw, 1945).

• **Diagnosis.** *Sauromalus hispidus* can be distinguished from all other congeners by the following combination of characteristics: absence of transverse dorsal body bands, possession of enlarged, spinose nuchal scales which are equal in size to or larger than the frontal plates in adults, and large (> 250 mm SVL) adult body size (Shaw, 1945).

• **Descriptions.** The original description by Stejneger (1891 [1892]) distinguished *Sauromalus hispidus* from *S. ater*. Detailed descriptions are included in Cope (1900), Schmidt (1922), Van Denburgh (1922), Shaw (1945) and Case (1982). Descriptions of selected anatomical features were published by de Queiroz (1987a). Robinson (1972, 1974) described the karyotype (2N = 36, with 12 macrochromosomes and 24 microchromosomes).

• **Illustrations.** Black and white drawings of dorsal, lateral, and ventral views of the head, midbody dorsal and ventral scale pattern, and the femoral pores and vent of the type specimen were published by Cope (1900). Schmidt (1922) included a close-up black and white photograph of the dorsal view of the head in an adult, illustrating the hispid nature of the nuchal scales. Other black and white photographs of adults were published by Van Denburgh (1922), Lindsay (1962), and Sylber (1985a). Carl and Jones (1979) and Sylber (1985a) published black and white photographs of juveniles. Lateral lymph sacs and nasal salt secretory glands were illustrated by Norris and Dawson (1964). Robinson (1972, 1974) illustrated the karyotype.

• **Distribution.** *Sauromalus hispidus* is found on the following islands in the Gulf of California, México: Ángel de La Guarda, Estanque (Pond), Granito, Mejia, San Lorenzo Norte, San Lorenzo Sur, Cabeza de Caballo, Coronado (Smith), La Ventana, Piojo and Fletcha (Grismer, 1994b). On the islands within the Bahía de Los Ángeles, the species is likely to have been introduced (Shaw, 1946; Case, 1982). Hybrids between *S. varius*, *S. hispidus*, and *S. obesus* are reported from Isla Alcatraz (Pelicano), Gulf of California, Sonora, México (Robinson, 1972; Case, 1982; Grismer, 1994b).

• **Fossil Record.** None.

• **Pertinent Literature.** A key to the species of *Sauromalus*, including *S. hispidus*, was presented in Smith and Taylor (1950). A bibliography of *Sauromalus* was published by Beaman et al. (1997). Specific topics include: natural history (Shaw, 1946; Blair, 1994); parasites (Newell and Ryckman, 1964); lateral lymph sacs and salt secretory glands (Norris and Dawson, 1964; Smits, 1986); thermoregulation (Norris, 1963); respiratory function (Bennett, 1971, 1972a, b, 1973a, b, 1982); metabolic enzyme activity (Bennett and Dawson, 1976); excretion of urate salts (Minnich, 1972); energetics and diet (Pough, 1973); social organization and mating (Case, 1982; Ryan, 1982; Carothers, 1984); reproduction, eggs, and hatchlings (Carl and Jones, 1979; Sylber, 1985a, b); colic modifications and evolution of herbivory (Iverson, 1980); evolution of body size and ecology (Case, 1978, 1982); origins and evolution (Murphy, 1983a, b; Grismer, 1994a, b); thermoregulation and feeding behavior (Smits, 1985a, b; Smits et al., 1986; Sylber, 1985b, 1988), physiological and morphological color change (Norris, 1967), captive management (Gray, 1995), phylogenetic relationships (de Queiroz, 1987a, b; Sites and Murphy, 1991); and systematics and evolution (Hollingsworth, 1995). Data on running endurance were presented by Garland (1994). Weldon et al. (1993) catalogued

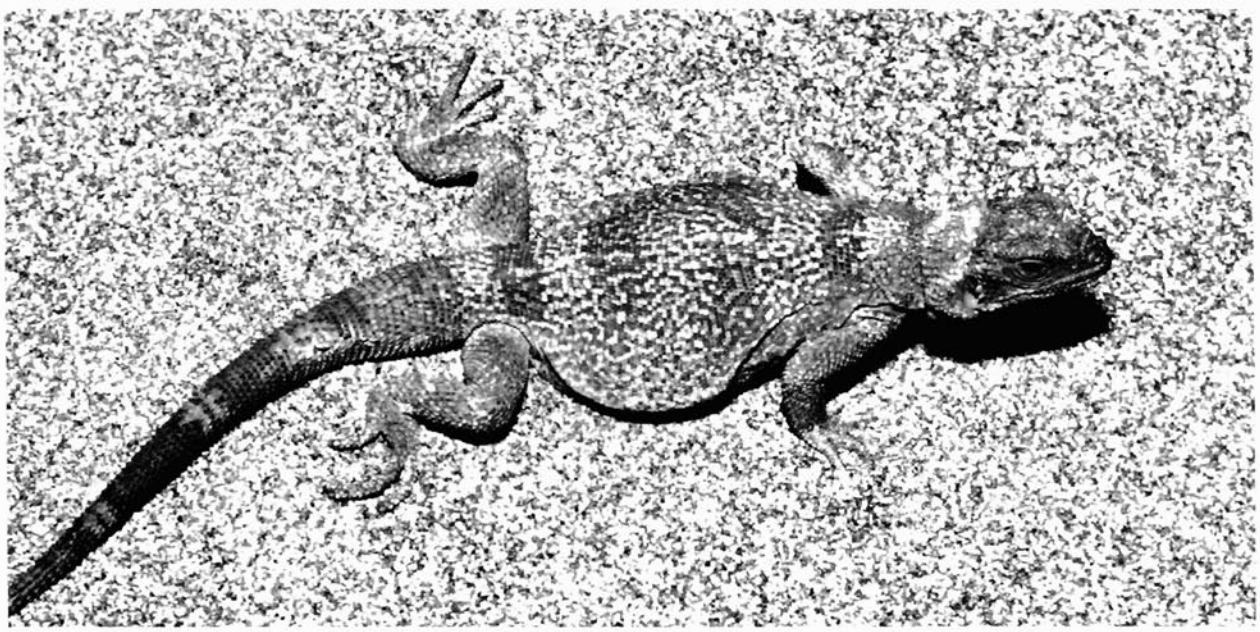


Figure 2. Juvenile *Sauromalus hispidus* from Ángel de La Guarda, Gulf of California, México.

dermatophagy in this species. Mellink (1995) included *S. hispidus* in a discussion of commercial trade in reptiles. Various authors have discussed the distribution of *S. hispidus* on islands in the Gulf of California (Lindsay, 1962; Soulé and Sloan, 1966; Loomis et al., 1974; Case, 1983; Murphy and Ottley, 1984; Grismer, 1994a, b).

• **Etymology.** The specific name *hispidus* comes from the Latin root *hisp* which means "shaggy" or "rough" and refers to the distinct nuchal scalation. The word chuckwalla or chuckawalla, originally written in Spanish as "chacahualla," is derived from the Shoshone word "*tcaxxwal*" or "*caxwal*," the form used by the Cahuilla Indians of southeastern California (Morris, 1971). Chuckwalla is more commonly used and is preferred.

• **Comment.** Various adaptational explanations have been presented to explain the evolution of body size with little or no regard to its historical or phylogenetic aspect (see Peters, 1983 and references therein). This is especially true for insular taxa which are notorious in having marked differences in body size from their closest mainland relatives (Case, 1978). The most notable feature of *Sauromalus hispidus* is its very large adult size as compared with the principally mainland species *S. australis* and *S. obesus* and the other insular endemic *S. ater* (*sensu* Robinson, 1972, 1974). Case (1982) attempted to explain the evolution of "insular gigantism" in *Sauromalus* by the interaction of two contemporary ecological models involving predator-prey relationships and food availability. An explanation may be accomplished in part by using a phylogeny of iguanine lizards (Norell and de Queiroz, 1991; Iguanidae of Frost and Etheridge, 1989) of which *Sauromalus* is a member. Within this group, *Sauromalus* forms a monophyletic group with *Amblyrhynchus*, *Conolophus*, *Ctenosaura*, *Iguana*, and *Cyclura* to the exclusion of *Brachylophus* and *Dipsosaurus*. All iguanid lizards, with the exception of two species of *Brachylophus* (Pregill and Dye, 1989), *Dipsosaurus*, three species of *Ctenosaura* (Bailey, 1928; Etheridge, 1982; de Queiroz, 1985, 1987a, b), and three species of *Sauromalus* (Berry, 1974; Case, 1982) are notable for having large adult body sizes (maximum SVL > 225 mm). Therefore, the most parsimonius (Maddison et al., 1984) inference is that large body size in *Sauromalus* is a primitive condition (i.e., a characteristic that was present in the ancestral *Sauromalus*). Rather than "insular gigantism," "continental dwarfism" may be the issue, because the latter is the evolutionarily derived characteristic which, based on the relationships of Norell and de Queiroz (1991), evolved subsequent to the evolution of the genus *Sauromalus*. The ecological models presented by Case (1992) for the "evolution of gigantism" in *Sauromalus* may support contemporary hypotheses for the selective forces maintaining large body size, but are not necessarily the causative factors behind this evolution. Furthermore, Case's (1982) hypotheses do not explain small size in the insular populations of *S. obesus* and *S. ater*. Future work concerning the evolution of differences in body size should include a phylogenetic interpretation as one of their hypotheses.

Grismer (unpubl. fld. notes) observed the tail of a hatchling impaled on a desert lavender (*Hyptis emoryi*) by a loggerhead shrike at Puerto Refugio on Isla Ángel de La Guarda in April 1989.

Literature Cited

Bailey, J.W. 1928. A revision of the lizards of the genus *Ctenosaura*. Proc. U.S. Natl. Mus. 73:1-55.

Beaman, K.R., B.D. Hollingsworth, H.E. Lawler, and C.H. Lowe. 1997. A bibliography of *Sauromalus* (Duméril 1856). Smithson. Herpetol. Info. Serv.:in press.

Bennett, A.F. 1971. Oxygen transport and energy metabolism in two species of lizards, *Sauromalus hispidus* and *Varanus gouldii*. Ph.D. Diss., Univ. Michigan, Ann Arbor.

—. 1972a. The effect of activity on oxygen consumption, oxygen debt, and heart rate in the lizards *Varanus gouldii* and *Sauromalus hispidus*. J. Comp. Physiol. 79:259-280.

—. 1972b. A comparison of activities of metabolic enzymes in lizards and rats. Comp. Biochem. Physiol. 42B:637-647.

—. 1973a. Blood physiology and oxygen transport during activity in two lizards, *Varanus gouldii* and *Sauromalus hispidus*. Comp. Biochem. Physiol. 46A:673-690.

—. 1973b. Ventilation in two species of lizards during rest and activity. Comp. Biochem. Physiol. 46A:653-671.

—. 1982. The energetics of reptilian activity, p. 155-199. *In* C. Gans and F.H. Pough (eds.), Biology of the Reptilia, Vol. 13, Physiology D: Physiological Ecology. Academic Press, London.

— and W.R. Dawson. 1976. Metabolism, p. 127-223. *In* C. Gans and W.R. Dawson (eds.), Biology of the Reptilia, Vol. 5, Physiology A. Academic Press, London.

Berry, K.H. 1974. The ecology and social behavior of the chuckwalla, *Sauromalus obesus obesus* Baird. Univ. California Publ. Zool. (101):vi + 60 p.

Blair, D.W. 1994. Chuckwallas. Reptiles: guide to keeping reptiles and amphibians 1(3):16-18, 20, 22.

Carl, G. and J.P. Jones. 1979. The eggs and hatchlings of *Sauromalus hispidus* (Reptilia, Lacertilia, Iguanidae). J. Herpetol. 13:293-296.

Carothers, J.H. 1984. Sexual selection and sexual dimorphism in some herbivorous lizards. Amer. Nat. 124:244-254.

Case, T.J. 1978. A general explanation for insular body size trends in terrestrial vertebrates. Ecology 59:1-18.

—. 1982. Ecology and evolution of the insular gigantic chuckawallas, *Sauromalus hispidus* and *Sauromalus varius*, p. 184-212. *In* G.M. Burghardt and A.S. Rand (eds.), Iguanas of the world: their behavior, ecology, and conservation. Noyes Publ., Park Ridge, New Jersey.

—. 1983. The reptiles: ecology, p. 159-209. *In* T.J. Case and M.L. Cody (eds.), Island biogeography in the Sea of Cortez. Univ. California Press, Berkeley.

Cope, E.D. 1900. The crocodilians, lizards, and snakes of North America. Ann. Rept. U.S. Natl. Mus. 1898:153-1270.

de Queiroz, K. 1985. Phylogenetic systematics of iguanine lizards: a comparative osteological study. M.S. Thesis, San Diego State University, San Diego, California.

—. 1987a. Phylogenetic systematics of iguanine lizards: a comparative osteological study. Univ. California Publ. Zool. (118):xii + 203 p.

—. 1987b. A new spiny-tailed iguana from Honduras, with comments on relationships within *Ctenosaura* (Squamata: Iguania). Copeia 1987:892-902.

Etheridge, R. 1982. Checklist of the iguanine and Malagasy lizards, p. 7-37. *In* G.M. Burghardt and A.S. Rand (eds.), Iguanas of the world: their behavior, ecology, and conservation. Noyes Publ., Park Ridge, New Jersey.

Frost, D.R. and R. Etheridge. 1989. A phylogenetic analysis and taxonomy of iguanian lizards (Reptilia: Squamata). Misc. Publ. Univ. Kansas Mus. Nat. Hist. (81):1-65.

Garland, T., Jr. 1994. Phylogenetic analyses of lizard endurance capacity in relation to body size and body temperature, p. 237-259. *In* L.J. Vitt and E.R. Pianka (eds.), Lizard ecology: historical and experimental perspectives. Princeton Univ. Press, Princeton, New Jersey.

Gray, R.L. 1995. San Esteban chuckwallas *Sauromalus varius:* an Arizona-Sonora Desert Museum delight. The Vivarium 6(4):52-54.

Grismer, L.L. 1994a. The origin and evolution of the peninsular herpetofauna of Baja California, Mexico. Herpetol. Nat. Hist. 2(1):51-106.

—. 1994b. Geographic origins for the reptiles on islands in the Gulf of California, Mexico. Herpetol. Nat. Hist. 2:17-40.
Hollingsworth, B.D. 1995. Systematics of chuckwalla lizards (*Sauromalus:* Iguanidae) and the evolution of Iguanidae. M.S. Thesis, San Diego State Univ., San Diego, California.
Iverson, J.B. 1980. Colic modifications in iguanine lizards. J. Morphol. 163:79-93.
Lindsay, G.E. 1962. The Belvedere Expedition to the Gulf of California. Trans. San Diego Soc. Nat. Hist. 13:1-44.
Loomis, R.B., S.G. Bennett, S.R. Sanborn, C.H. Barbour, and H. Weiner. 1974. A handlist of the herpetofauna of Baja California, Mexico & adjacent islands. Priv. printed, California State Univ., Long Beach.
Maddison, W.P., M.J. Donoghue, and D.R. Maddison. 1984. Outgroup analysis and parsimony. Syst. Zool. 33:83-103.
Mellink, E. 1995. The potential effect of commercialization of reptiles from Mexico's Baja California peninsula and its associated islands. Herpetol. Nat. Hist. 3:95-99.
Minnich, J.E. 1972. Excretion of urate salts by reptiles. Comp. Biochem. Physiol. 41A:535-549.
Morris, W. (ed.). 1971. The American Heritage dictionary of the English language. American Heritage Publ. Co., Inc. and Houghton Mifflin Co., New York.
Murphy, R. 1983a. Paleobiogeography and genetic differentiation of the Baja California herpetofauna. Occ. Pap. California Acad. Sci. (137):1-48.
—. 1983b. The reptiles: origins and evolution, p. 130-158. *In* T.J. Case and M.L. Cody (eds.), Island biogeography in the Sea of Cortez. Univ. California Press, Berkeley.
— and J.R. Ottley. 1984. Distribution of amphibians and reptiles on islands in the Gulf of California. Ann. Carnegie Mus. 53:207-230.
Newell, I.M. and R.E. Ryckman. 1964. *Hirstiella pyriformis* sp. n. (Acari, Pterygosomidae), a new parasite of lizards from Baja California. J. Parasitol. 50:163-171.
Norell, M.A. and K. de Queiroz. 1991. The earliest iguanine lizard (Reptilia: Squamata) and its bearing on iguanine phylogeny. Amer. Mus. Novitates (2997):1-16.
Norris, K.S. 1963. Preparations of radiotelemetry of the body temperatures of large reptiles, p. 283-287. *In* L.E. Slater (ed.), Bio-telemetry. Pergamon Press, London.
—. 1967. Color adaptation in desert reptiles and its thermal relationship, p. 162-229. *In* W.W. Milstead (ed.), Lizard ecology: a symposium. Univ. Missouri Press, Columbia.
— and W.R. Dawson. 1964. Observations on the water economy and electrolyte excretion of chuckwallas (Lacertilia, *Sauromalus*). Copeia 1964:638-646.
Peters, R.H. 1983. The ecological implications of body size. Cambridge Univ. Press, New York.
Pough, F.H. 1973. Lizard energetics and diet. Ecology 54:837-844.
Pregill, G.K. and T. Dye. 1989. Prehistoric extinction of giant iguanas in Tonga. Copeia 1989:505-508.
Robinson, M.D. 1972. Chromosomes, protein polymorphism, and systematics of insular chuckwalla lizards (genus *Sauromalus*) in the Gulf of California, Mexico. Ph.D. Diss., Univ. Arizona, Tucson.
—. 1974. Chromosomes of the insular species of chuckwalla lizards (genus *Sauromalus*) in the Gulf of California, Mexico. Herpetologica 30:162-167.
Ryan, M.J. 1982. Variation in iguanine social organizatin: mating systems in chuckawallas (*Sauromalus*), p. 380-390. *In* G.M. Burghardt and A.S. Rand (eds.), Iguanas of the world: their behavior, ecology, and conservation. Noyes Publ., Park Ridge, New Jersey.
Schmidt, K.P. 1922. The amphibians and reptiles of Lower California and neighboring islands. Bull. Amer. Mus. Nat. Hist. 46:607-707.
Shaw, C.E. 1945. The chuckwallas, genus *Sauromalus*. Trans. San Diego Soc. Nat. Hist. 10:269-306.
—. 1946. A new locality for the spiny chuckwalla, *Sauromalus hispidus*. Copeia 1946:254.
Sites, J.W., Jr. and R.W. Murphy. 1991. Isozyme evidence for independently derived, duplicate G3PDH loci among squamate reptiles. Can. J. Zool. 69:2381-2396.
Smith, H.M. and E.H. Taylor. 1950. An annotated checklist and key to the reptiles of Mexico exclusive of the snakes. Bull. U.S. Natl. Mus. (199):v + 253 p.
Smits, A.W. 1985a. Correlates of activity, diet, and body water flux in the chuckwalla, *Sauromalus hispidus*. Physiol. Zool. 58:166-174.
—. 1985b. Behavioral and dietary responses to aridity in the chuckwalla, *Sauromalus hispidus*. J. Herpetol. 19:441-449.
—. 1986. Accessory lymph sacs and body fluid partitioning in the lizard, *Sauromalus hispidus*. J. Exp. Biol. 121:165-177.
—, J. Ward, and H. Lillywhite. 1986. Effects of hyperalemia on thermoregulatory and feeding behaviors of the lizard, *Sauromalus hispidus*. Copeia 1986:518-520.
Soulé, M. and A.J. Sloan. 1966. Biogeography and distribution of the reptiles and amphibians on islands in the Gulf of California, Mexico. Trans. San Diego Soc. Nat. Hist. 14: 137-156.
Stejneger, L. 1891 (1892). Description of a new North American lizard of the genus *Sauromalus*. Proc. U.S. Natl. Mus. 14:409-411.
Streets, T.H. 1877. Contributions to the natural history of the Hawaiian and Fanning Islands and Lower California, made in connection with the United States North Pacific surveying expedition, 1873-1875. Bull. U.S. Natl. Mus. (7):1-172.
Sylber, C.K. 1985a. Eggs and hatchlings of the Yellow Giant Chuckwalla and the Black Giant Chuckwalla in captivity. Herpetol. Rev. 16:18-21.
—. 1985b. Feeding habits, reproduction and relocation of insular giant chuckwallas. Ph.D. Diss., Colorado State Univ., Fort Collins.
—. 1988. Feeding habits of the lizards *Sauromalus varius* and *S. hispidus* in the Gulf of California. J. Herpetol. 22:413-424.
Van Denburgh, J. 1922. The reptiles of western North America. Vol. I. Lizards. Occ. Pap. California Acad. Sci. (10):1-611.
Weldon, P.J., B.J. Demeter, and R. Rosscoe. 1993. A survey of shed skin-eating (dermatophagy) in amphibians and reptiles. J. Herpetol. 27:219-228.

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